Inflation-era High Energy Physics and neutrino masses via CMB polarization measurements with the South Pole Telescope

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Critical component: Argonne TES Detector Development Project featuring HEP, MSD, and CNM.

COLLABORATORS:

South Pole Telescope collaboration including key people at:
Kavli Institute for Cosmological Physics at the University of Chicago,
U.C.Berkeley & LBL, U.Colorado, Case Western & McGill University

*joint Argonne/U.Chicago

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HEP provides enabling technology for frontier research - excellent synergy.
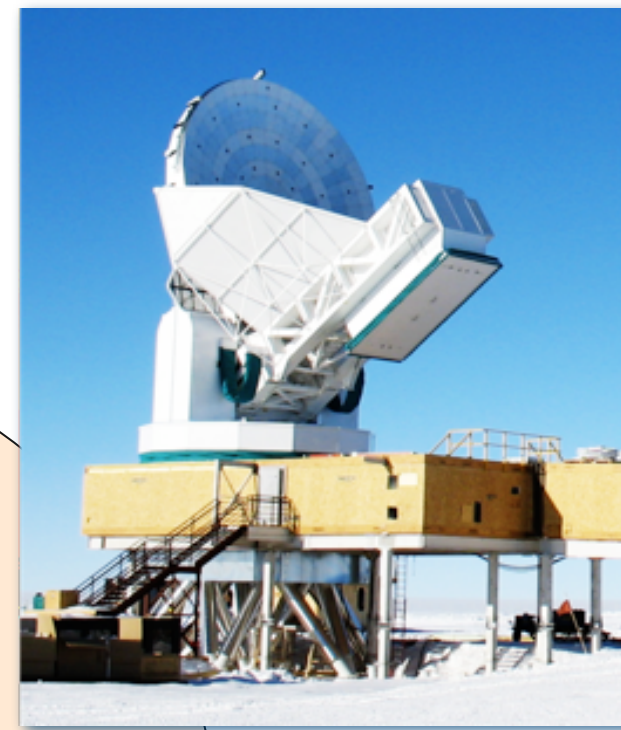
TECHNOLOGY

- Superconducting Transition-Edge Sensor (TES) Detectors
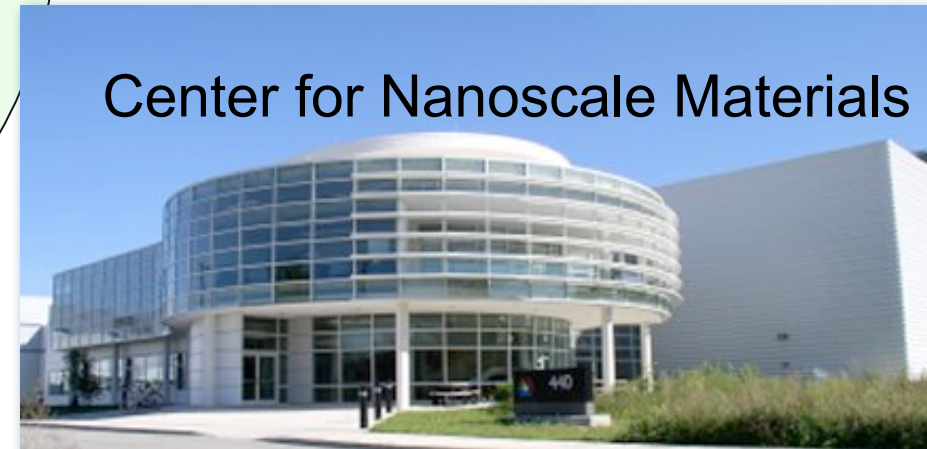- Argonne TES Development Project
- Seeded by LDRD (ANL)

PLATFORM

- South Pole Telescope. Cutting edge instrument & strong collaboration
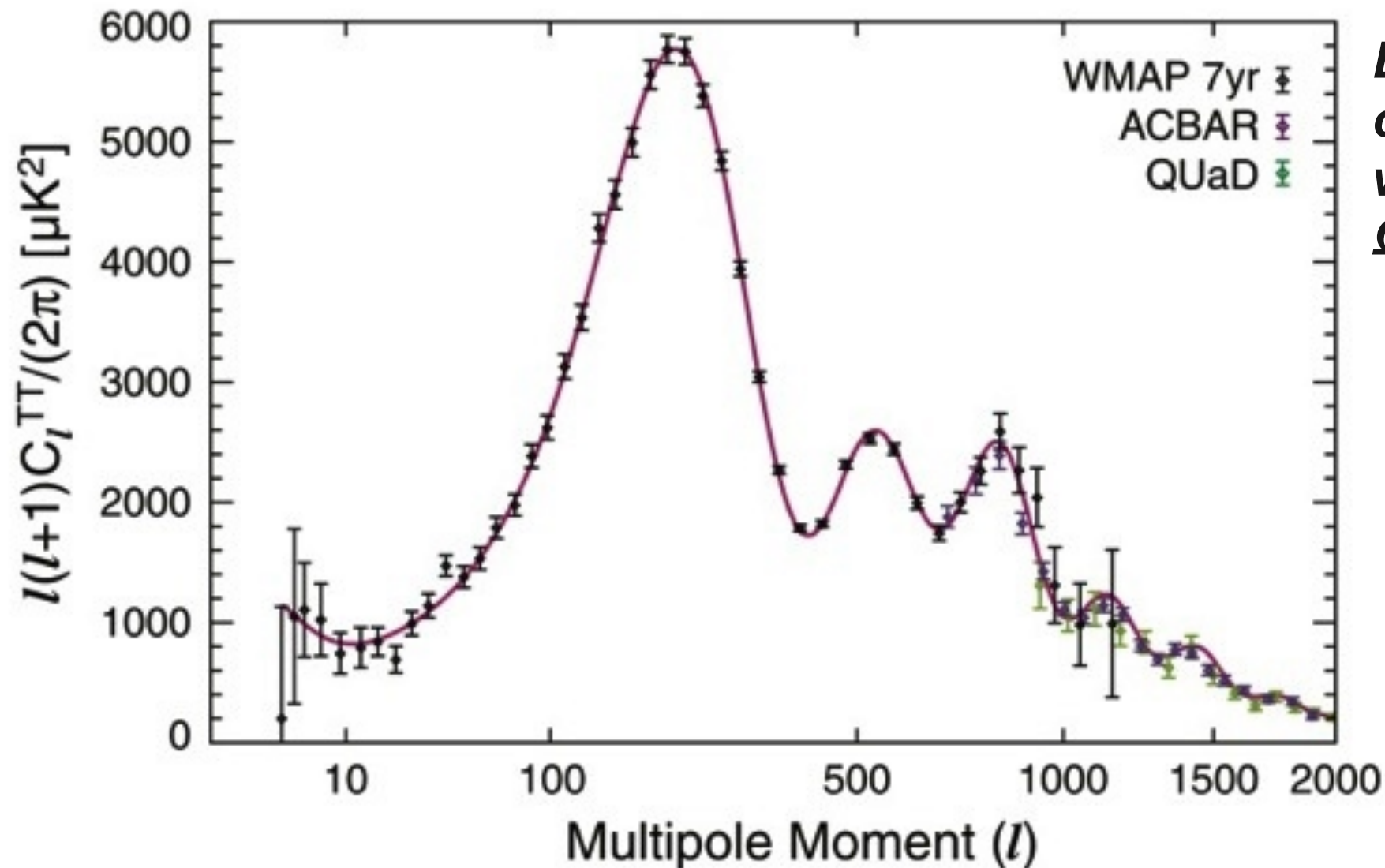- PI: John Carlstrom

SPTpol

HEP Science

Center for Nanoscale Materials

# CMB measurements have been an Incredible success!

Line is fit to a flat ΛCDM cosmology model with just six parameters: $\Omega_b h^2$, $\Omega_m h^2$, A_s, τ, n_s, Ω_Λ

What's next?   "B-mode" CMB polarization to probe Inflation.

The data from SPTpol will constrain the masses of the neutrinos and set (or limit) the energy scale of Inflation.
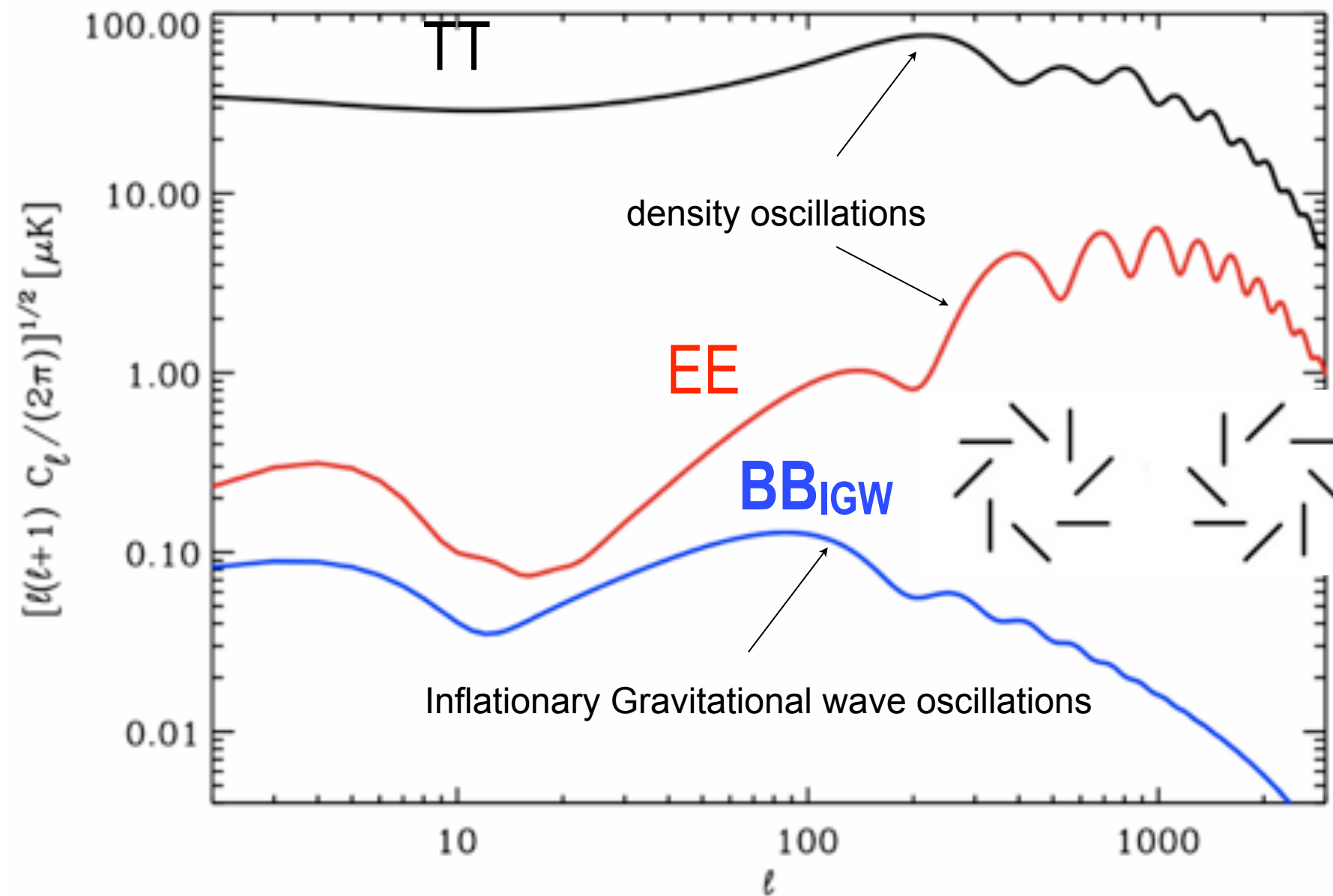
Komatsu et al., arXiv:1001:4538; Larson et al., arXiv:1001.4635
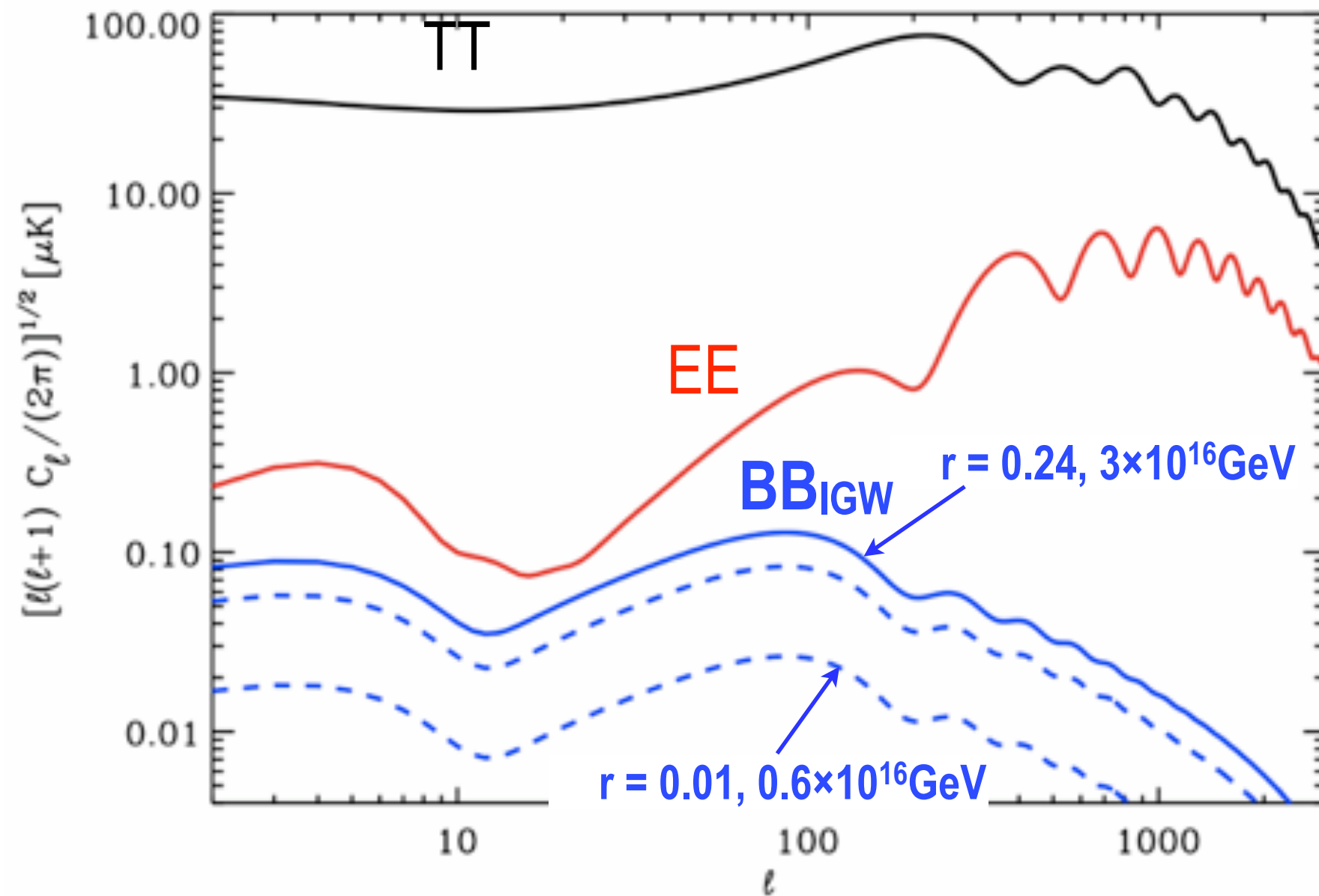
CMB angular power spectra
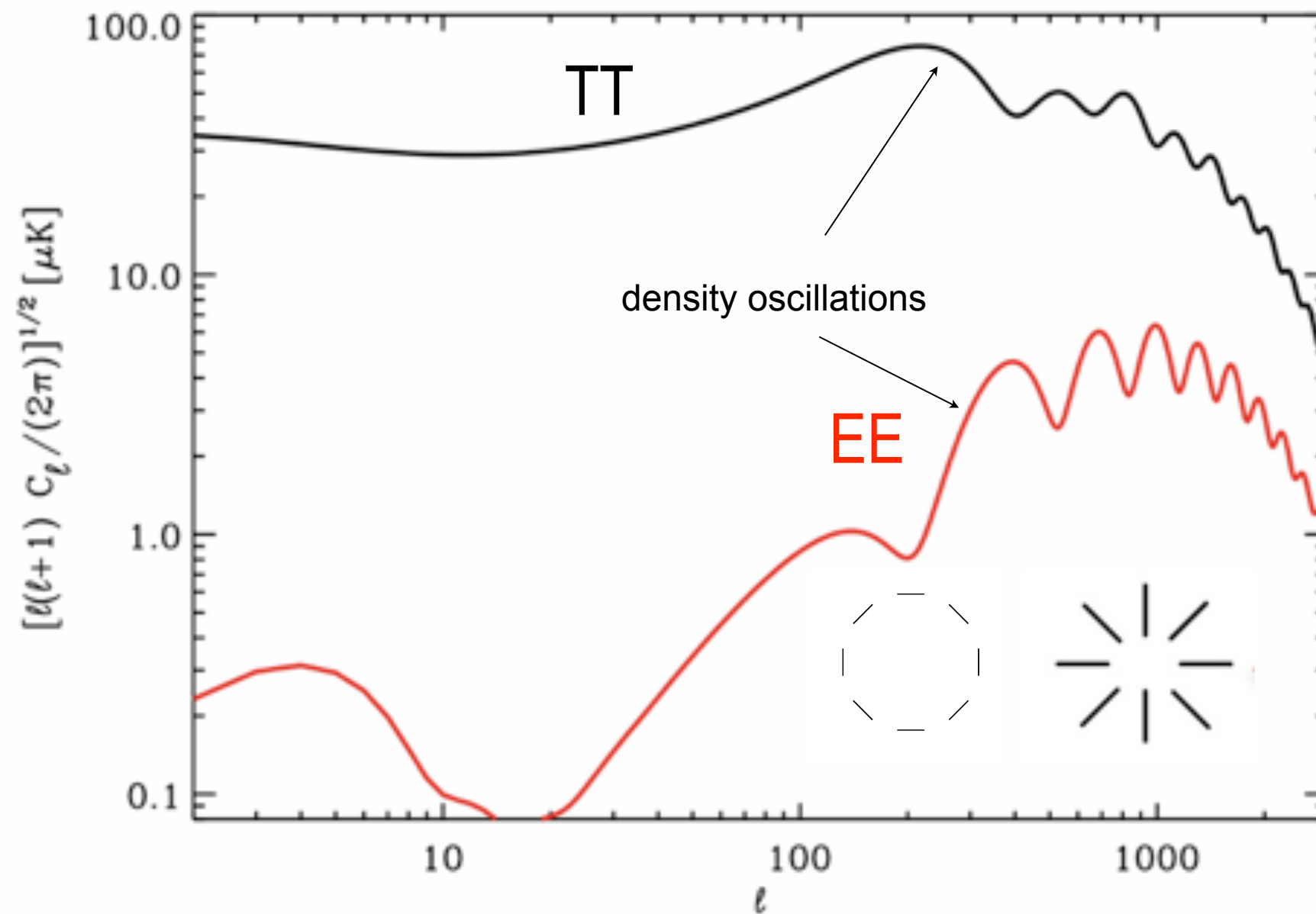
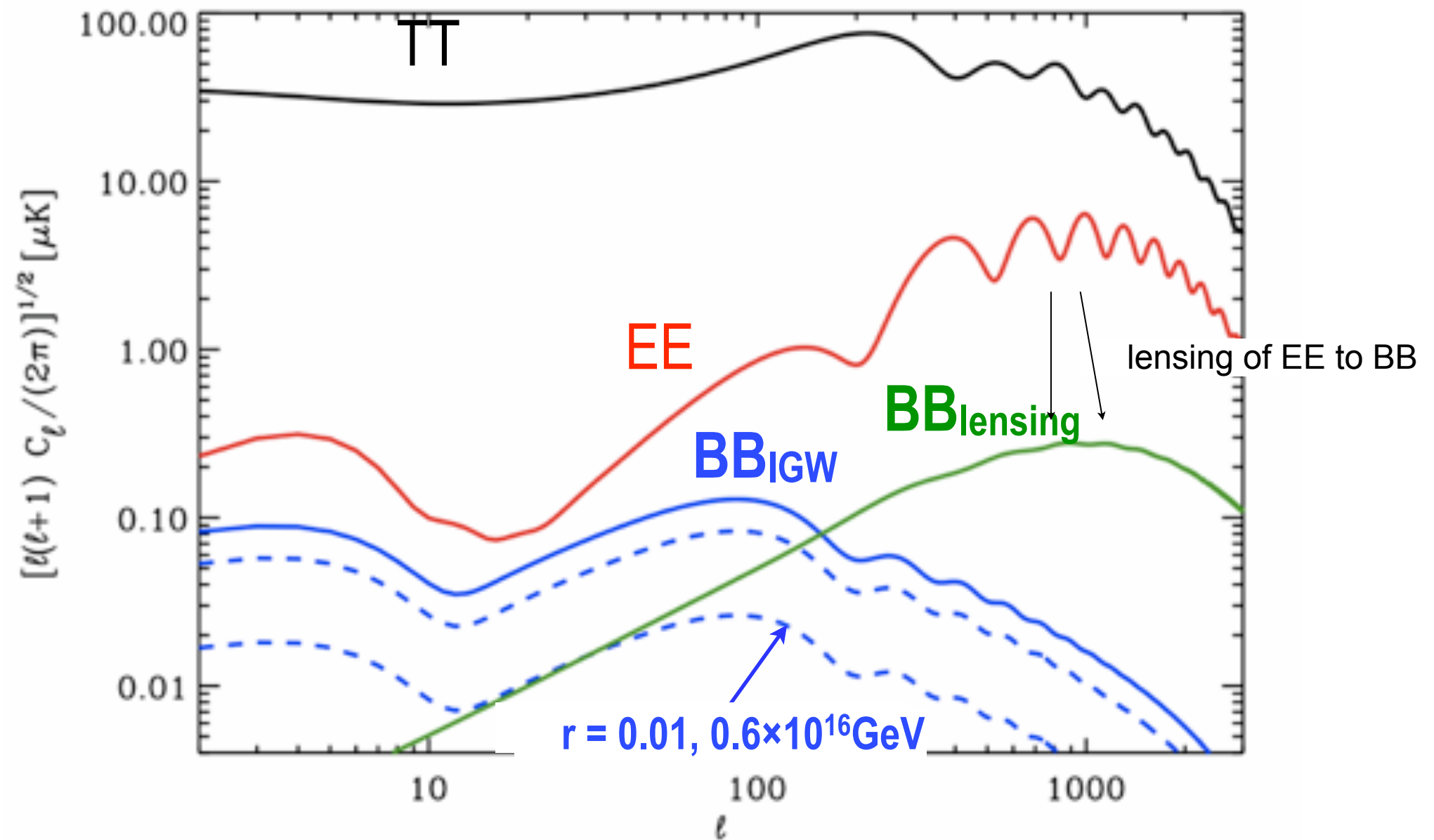Spectra generated with WMAP7 parameters using CAMB, Lewis and Challinor
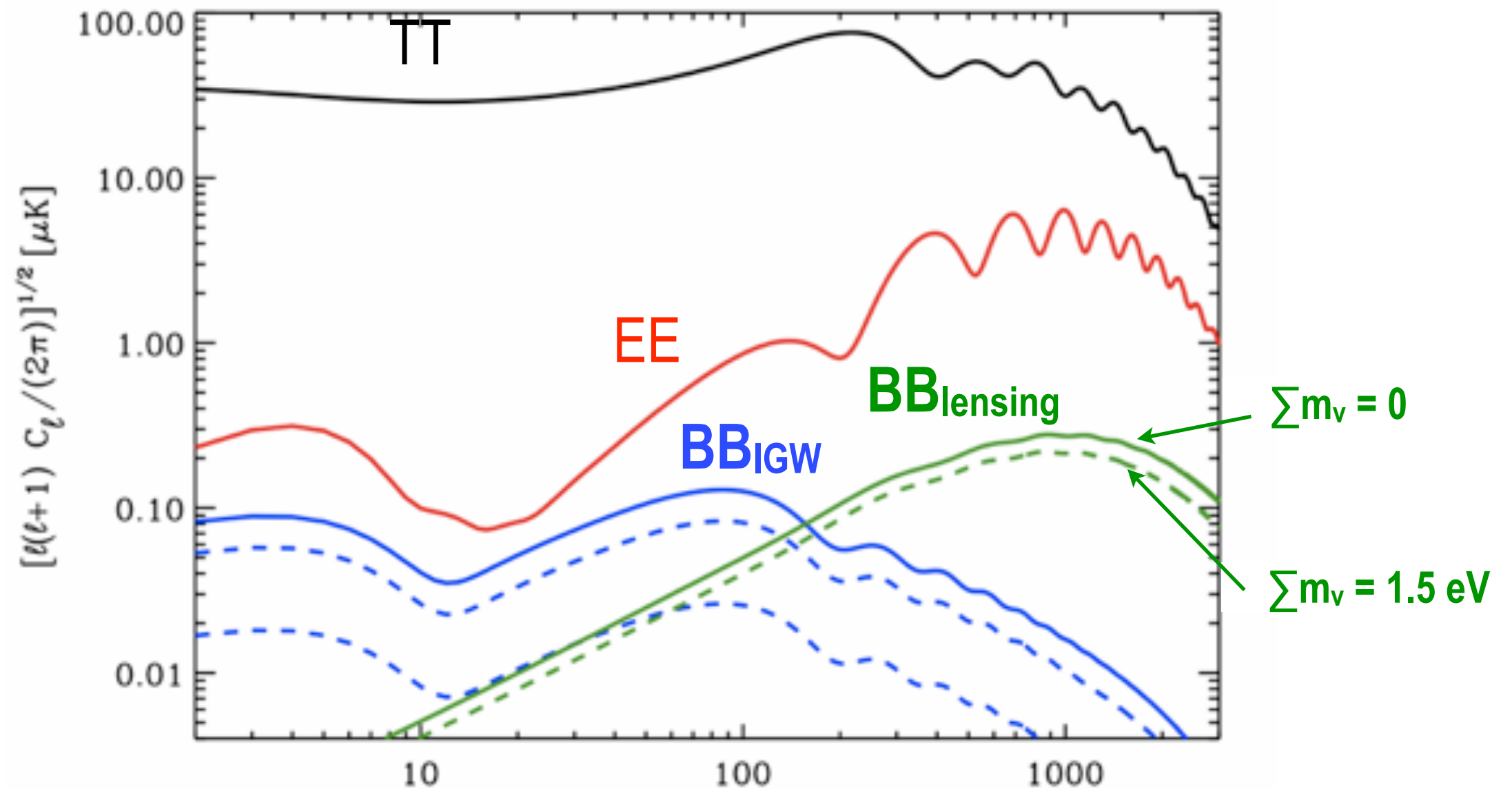
CMB angular power spectra

CMB angular power spectra
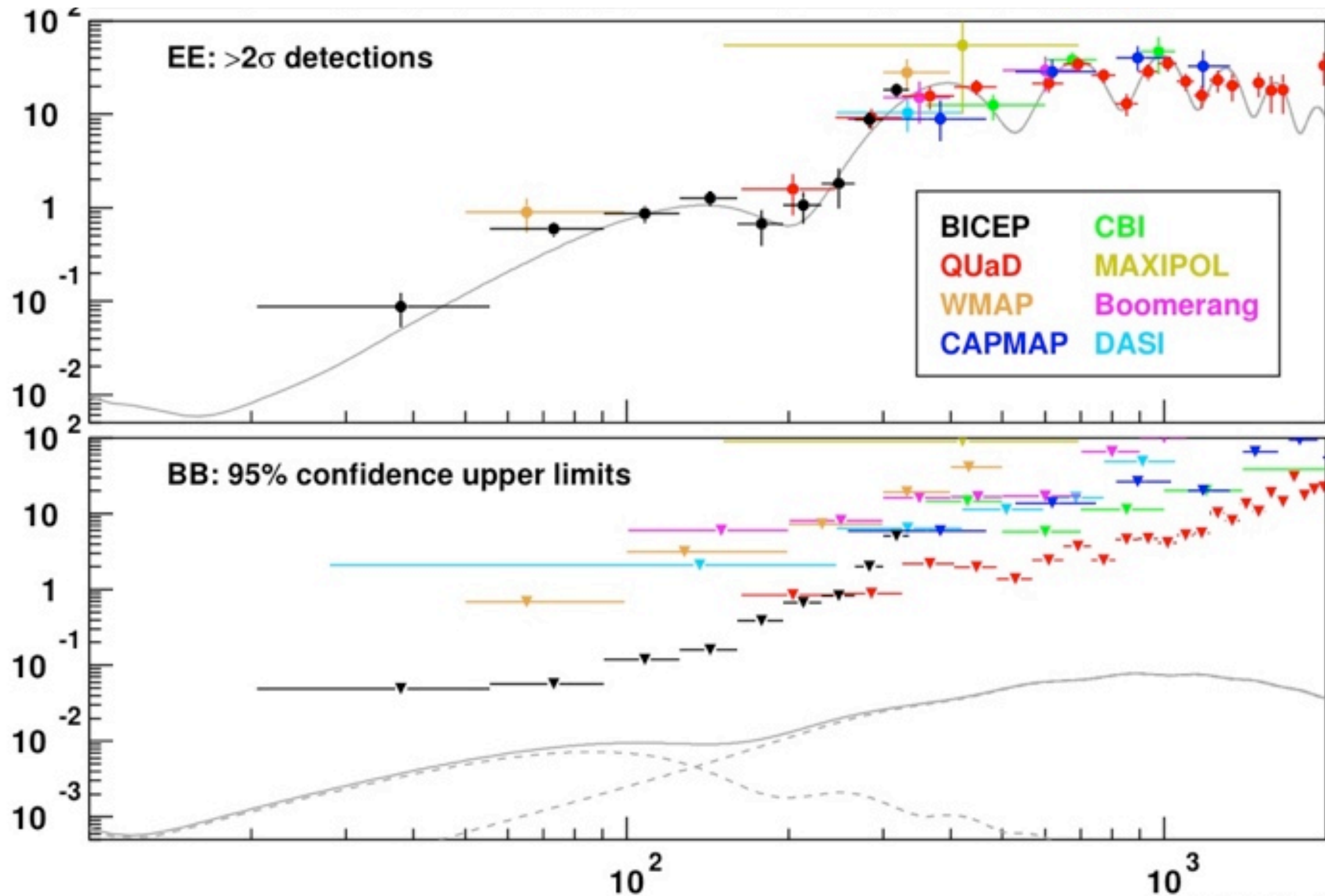
CMB angular power spectra

CMB angular power spectra

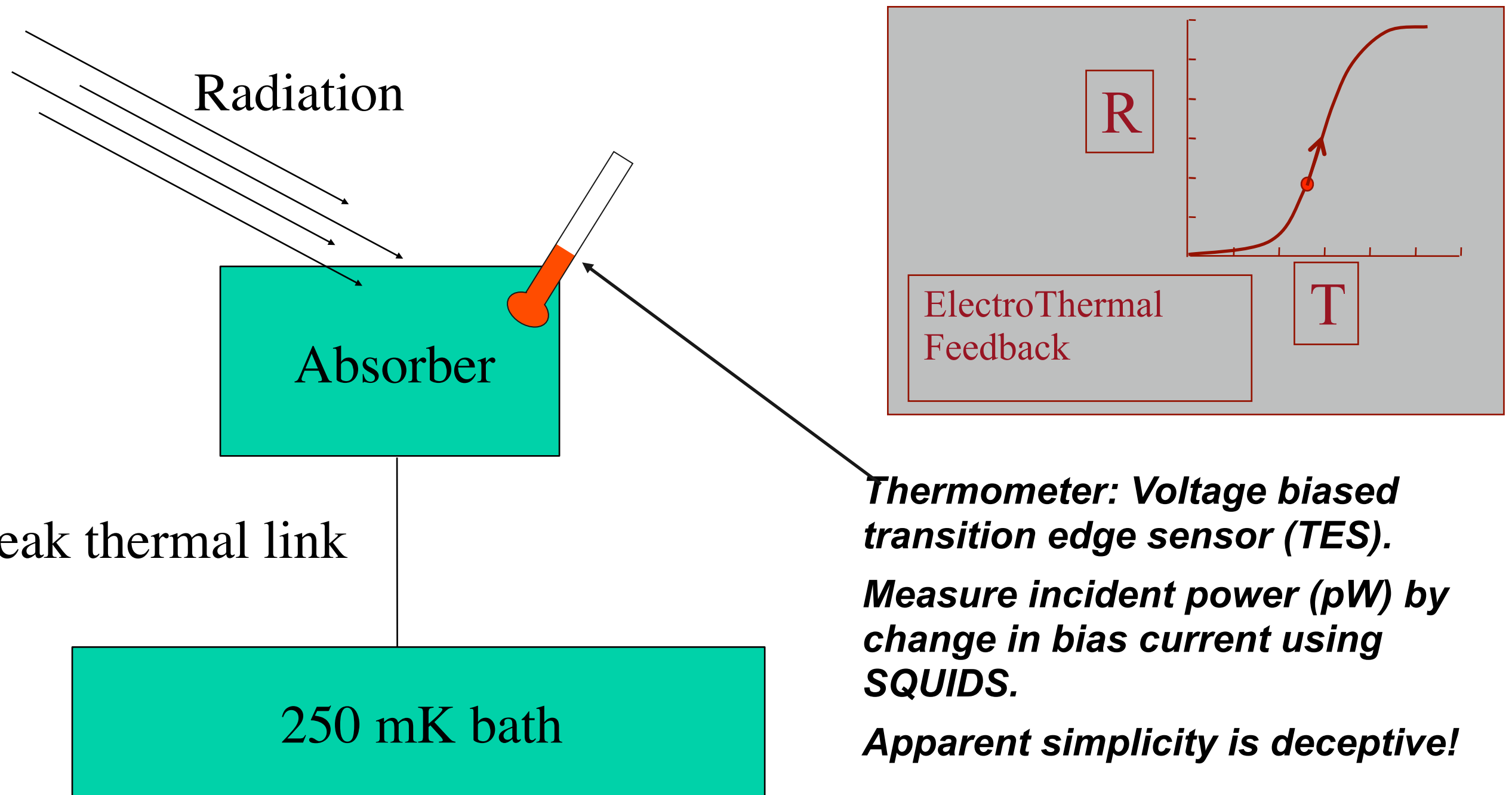**CMB measurements should be able to achieve σ(∑m_v) = 0.05eV, comparable to Δm measured by neutrino oscillations.**
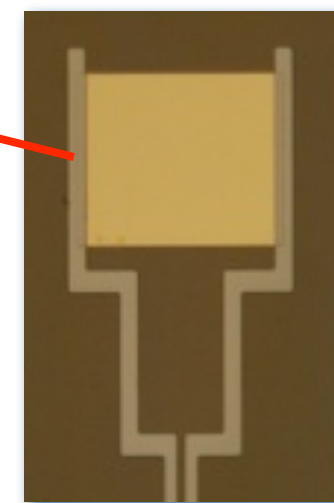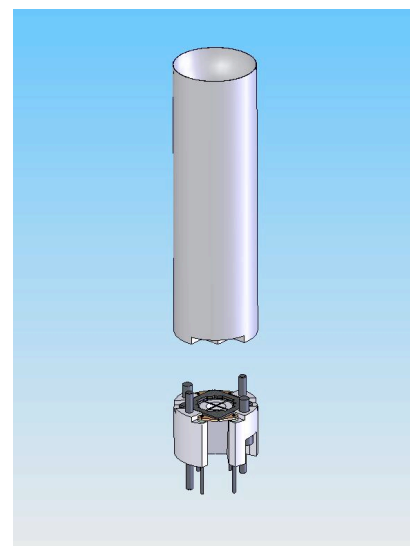
Closing in on inflation

EE: >2σ detections

BICEP	CBI
QUaD	MAXIPOL
WMAP	Boomerang
CAPMAP	DASI

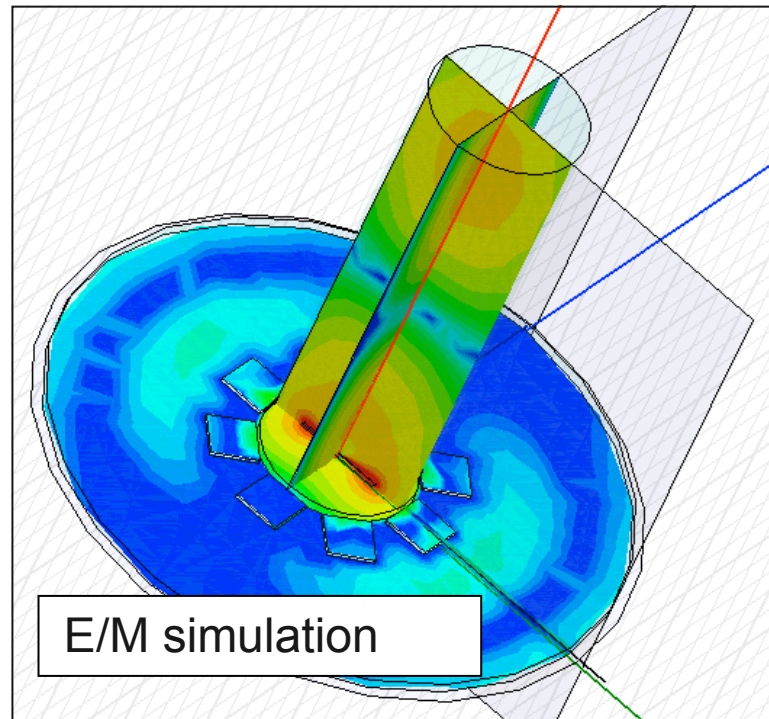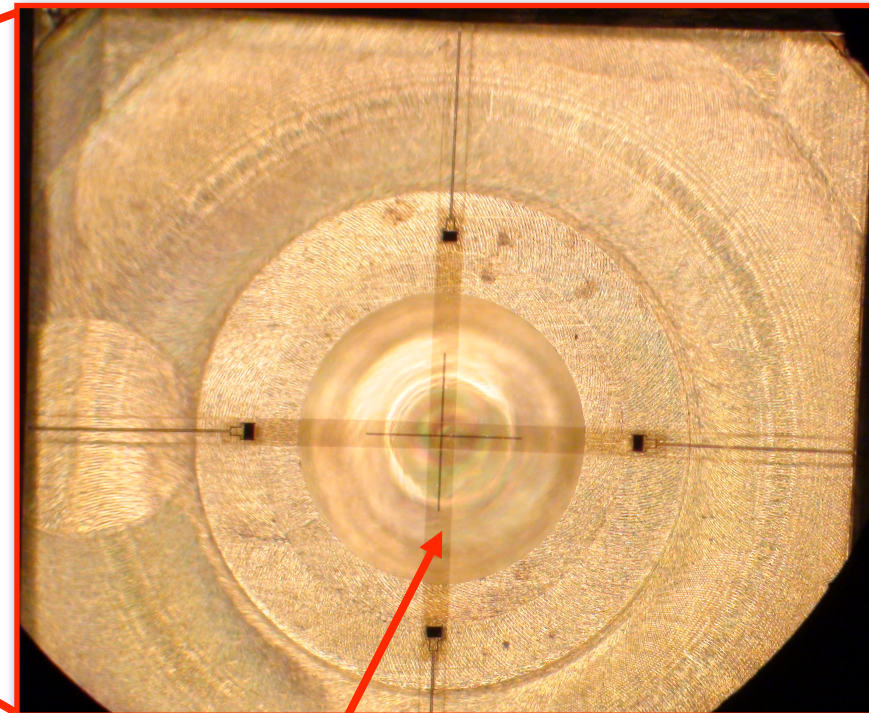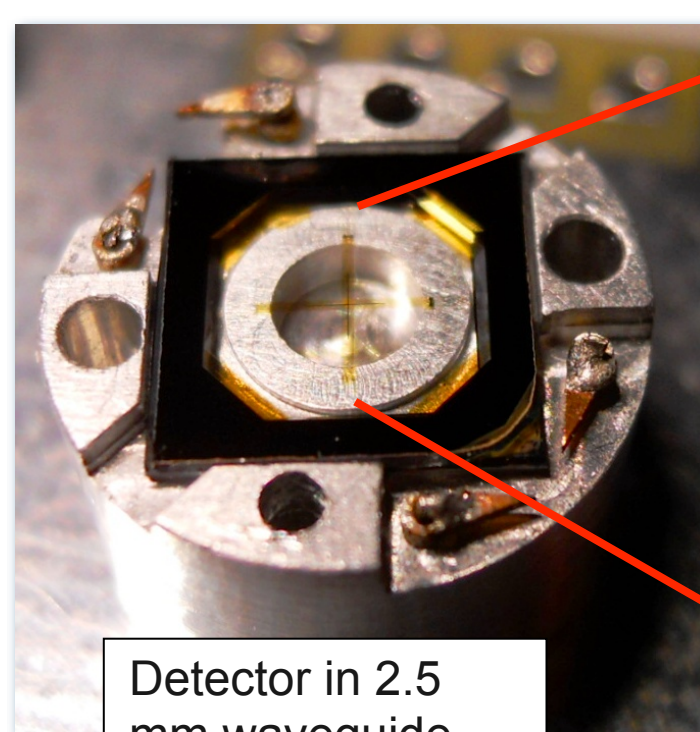BB: 95% confidence upper limits

see Brown et al., arXiv:0906.1003 & Chiang et al., arXiv:0906.1181

Need more sensitivity! Need scalable, background limited, detectors.

Bolometry: A Broadly Applicable, Ultra-Sensitive Thermal Detection

Radiation

Absorber

Weak thermal link

250 mK bath

R

ElectroThermal Feedback

T

Thermometer: Voltage biased transition edge sensor (TES).

Measure incident power (pW) by change in bias current using SQUIDS.

Apparent simplicity is deceptive!

LDRD developed Argonne SPTpol TES Detector

input waveguide (from feed horn)

crossed gold bar absorbers (on separate planes)

choke

backshort

Detector in 2.5 mm waveguide mount

E/M simulation
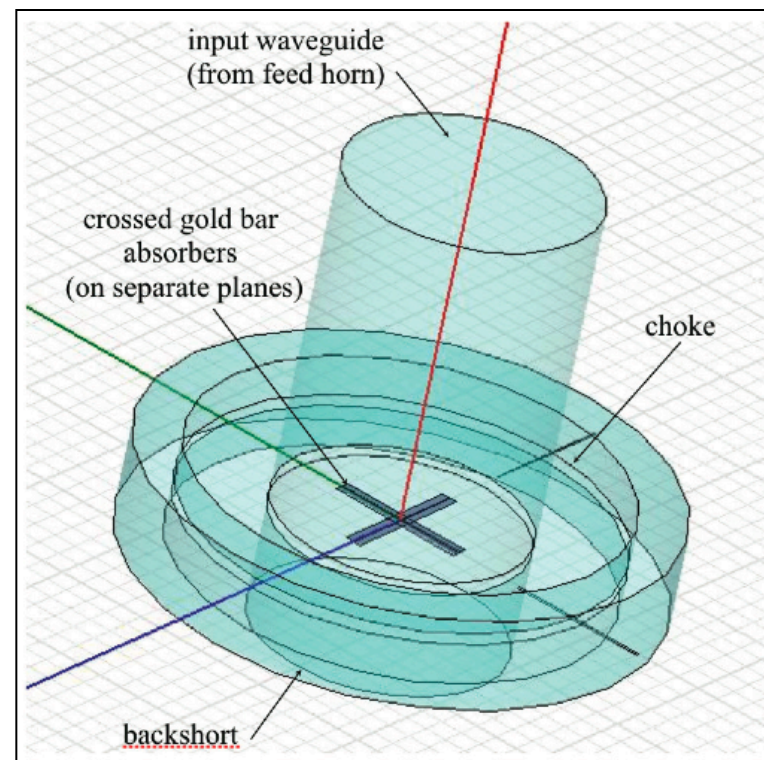
Mo/Au proximity effect 500mK T_C bilayer TES

Argonne participation in South Pole Telescope science (SPT-SZ, DES+SPT, SPTpol).

Argonne TES polarization sensitive detector unique and critical contribution to SPTpol (LDRD funded development).

First SPTpol focal plane deployment Nov 2011.

Continued improvements through 2015.

Path for detectors for next generation CMB polarization projects and other applications.